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Severing Glass

By Roy E. Swain[1]

SEVERING glass into smaller units has brought to the glassworker many serious problems and the solutions found have seldom if ever been entirely satisfactory, so a study of severing as a whole may assist some in discovering a more satisfactory method of working or improving the methods now used.

Glass in the molten state at temperatures considered best for working is a viscous liquid possessing ductility to an extent equalled by few other materials. While these properties are made use of in the forming of glassware they also furnish the glassworker with some very serious problems in connection with separating the glass into small units to produce the individual articles.

It has been suggested that the proper amount of batch material or finely crushed glass be placed in the mold and melted to form the article. The possibility that such an arrangement would be a success is remote as glass at the temperature necessary for fusion would attack the mold made of any ordinary mold-making material and form adhesions.

Handworkers gather the glass on pipes or punties by turning them in the glass. When the desired amount of glass has been accumulated the gathering is raised clear of the pool of glass. Between the gathering and the pool of glass there is a stream or string of glass that must be broken. This is usually done in the tank or pot by maneuvering the gathering to burn off the thread. In many of the smaller and cheaper articles the thread may be broken outside the furnace and in working the softer glasses the scar will heal over.

Once outside the furnace we have the problem of removing the proper amount of glass from the punty. The body of the glass can be deposited in the mold but the connecting thread cannot be burned off as within the furnace so some mechanical means must be used. The presser uses a pair of extra heavy household shears to sever this stream of glass but the handle setter or foot maker often uses shears having V-shaped blades to constrict the stream of glass as well as cut it.

The gathering removed from his punty, the punty gatherer must then remove the excess glass from his punty before gathering again. Two methods of removing this excess glass have been devised. In making medium sized or larger ware a bar known as a kettle-plate is provided to marver the excess glass to the outer end of the punty. Then by rolling along the projecting edge of the plate the surplus glass is cut off. In the pressing of smaller articles a foundation of hot glass is laid on the kettle-plate and the excess glass is removed from the punty by wiping over this hot glass. It is also possible in cases where small articles are being made from hot glass to return the excess glass to the gathering pool and deposit it on the surface in such a manner that it will reheat without causing defects in the glass.

In semi-automatic pressing the shears, being operated mechanically, vary somewhat in design but the action is similar even though V-shaped blades are used or a straight line movement given the blades. The thin blades are popular in automatic work and the blades are given a V or U shape to centralize the stream of glass and shorten the shearmark.

The finisher of pressed or blown glass often removes excess glass or produces irregular shapes by warming in the blank and shearing. The blank is then warmed in again to remove the scar and finish shaping.

Blownware

In blownware the article is practically shaped before the problem of severing confronts the workman. In off-hand work there are exceptions as in the case of the lamp chimney where an opening is required in the lower end of the article. This opening is made by cutting down with the tools to form a constriction near the end of the blank. This cutting down not only reduces the cross sectional area but also produces a certain amount of strain. A sharp rap on the knob thus formed will cause a fracture at the constriction, so producing an opening for the tools to enter to form the heel of the chimney. This same method is used in the manufacture of other articles such as globes, shades, funnels, etc., which may be required in such small quantities as to make elaborate mold equipment too expensive. The opening thus formed is crazed and irregular but the warming in and opening removes these defects.

After the off-hand article has been fashioned it must be removed from the pipe. The blower usually contemplates this and cuts down with the tools on the finishing line mak-

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ing a slight constriction and providing a guiding track for the tools when he later tools the glass to impart the strain that assists in cracking off the article. This fractured surface is also more or less uneven and is made presentable only by warming in and finishing.

It is characteristic of glass that the fractures seldom, if ever, produce plain surfaces, so severing by fracture requires a finishing operation to secure a presentable or safe finish unless the glass is mounted to conceal the edge as in the case of window-panes, picture glasses, headlight covers, etc.

While the hand-blowing of window glass is all but a memory the methods of severing used are worth mentioning. The older method of capping a cylinder consisted of drawing a thread from a bit of glass and wrapping this thread of hot glass around the cylinder where it was desired to remove the cap. This hot glass set up a strain sufficient to cause the cap to crack off. Later in some plants electric resistance wires took the place of the thread of glass. The principle and results were the same except that the wire was more easily handled than the thread of glass. The cylinders were then split by running a hot rod in contact with the inside surface of the cylinder.

In mold-blown ware we find several methods in use for removing the article from the pipe. These methods differ with the size of the articles, the number being made and the glass conditions. Small pastemold ware is sometimes removed from the pipe by stripping the moil from the pipe but this requires a very hot blowover to prevent the formation of cracks that may run into the article itself. A large and very light blowover is sometimes blown on small pastemold ware. This thin glass sets almost instantly and by the pipe. A rolling cutter is sometimes placed near the top of the pastemold to produce a constriction. Quite a strain is set up in this section as the roller is kept free from paste and is cooled by the water used to wet and cool the mold. Striking the article on an asbestos pad completes the fracture. Clean iron pastemold ware may be blown with a small blowover and removed from the pipe by means of a chisel placed at the end of the pipe and the pipe given a sharp rap on a bar as shown in the sketch.

In the German system, pastemold ware of the larger sizes the blowover is too heavy for the use of these methods so a small quantity of water is placed on the glass near the end of the pipe by means of a swab or by pouring. This water sets up a number of small cracks that so weaken the glass that a sharp rap on the pipe completes the break. The gatherer usually cuts down the ball at the end of the pipe to assist in cracking off the ware. This method is also used to remove large ironmold ware from the pipe.

Medium-sized ironmold ware made by the German system method is often blown with a medium light blowover. This blowover while strong enough to permit of handling the article by means of the pipe is easily broken to separate the article from the pipe.

Smaller ironmold ware made by the American or clean-iron method is usually removed from the pipe by means of a light blowover before the ware is taken from the mold. The bottle blowers are adept at forming blowovers and use but a minimum of glass but the wide-mouthed articles require more time and also use a greater amount of glass in the formation of the blowover. The problem of preventing fine glass from falling into the article has been solved by the use of two well-known methods. Should it be necessary to work the glass comparatively stiff a spheroid is usually blown over the mold. When this ball has set, which requires only a fraction of a second, a slight upward movement of the pipe will tear the ball at or below the equator with very little shattering. The other method appears a little more elaborate and requires that the glass be worked comparatively hot. It is, however, more rapid and furnishes the article better protection from falling glass. This method consists of drawing a stem over the mold, making an elbow in the stem and blowing a small ball over the article. A slight twist of the pipe breaks the stem at the elbow leaving the light bubble of glass over the article.

A method of removing surplus glass from ironmold blown ware consists of cutting a cavity in the mold just beyond the finishing line. Glass blown into this cavity is blown very thin and after annealing the article a light tap will break the light section of glass leaving a fin of glass around the edge of the article. Then by means of saws, files or threaded rods the surplus glass is chipped off to the finishing line.

The mold designer provides a small beading in the mold that not only indicates the finishing line but assists the blower in keeping the thickness of his glass uniformly heavy up to the finishing line. Blowovers are usually removed in the same manner or by use of the same tools but in the case of the heavier articles the blowover may be removed by means of wire brushes or by the hammering of a number of small dogs attached to a rapidly revolving spindle. After the greater portion of the surplus glass has been removed the edge of the article is usually ground to complete the operation and produce a smoother finish.

Surplus glass is removed from many of the pastemold and light ironmold articles by burning off immediately after the article leaves the mold. This method of finishing has several manufacturing advantages as well as producing an exceptionally strong and smooth finish. One of the manufacturing advantages of burning off is better annealing, as the article is completed before annealing thus preventing the introduction of cutting and glazing strains in the finishing process. Removal of the waste glass also cuts down the lehr space necessary to handle a given number of articles. The waste glass is usually heavier than the article itself so that removing the waste glass permits the use of a more rapid annealing schedule. The finished articles may be selected and packed as they come through the lehr, thus cutting down the time, labor and losses of handling.

In the finishing department many methods have been devised to remove waste or surplus glass. Some of these methods have been devised to meet peculiar conditions but may have some value in working out similar problems. Cutting devices usually rely upon scoring, an application of heat or a combination of the two to produce the desired result. For cutting sheet glass the scoring method is used. Diamonds or rolling steel cutters are used to score the glass. After scoring a flexing of the sheet completes the fracture.

A burner producing a fine pointed flame may be used as a

source of heat. The flame is pointed directly on the finishing line and a number of burners may be used in a series. Another burner consists of a substantially closed combustion chamber having a long slot but a few thousandths of an inch in width to permit the escape of the hot gases. These hot gases are directed onto the finishing line and will usually set up sufficient strain to cause cracking off, but the action is speeded up and made more certain by the use of a scoring device and the application of moisture.

Some glasses do not cut well by flame but may be worked by means of an electric resistance wire shaped to circumscribe the article as far as possible. The hot wire is held in contact with the article and the article rotated to equalize the distribution of the heat. The fracture may be aided, as in the use of flame, by the use of a scoring device and an application of moisture.

Small tubular articles are often made several to a stick and separated in the finishing department. Where a small groove may be provided at each of the finishing lines, the articles or stick may be chucked in a small lathe and a soft iron wire brought to bear in each groove. Rapidly spinning the article sets up sufficient friction to bring the wires to a red heat. Followed by an application of moisture this proceeding will produce a very clean fracture.

Where speed is more important than neatness a soft steel disc having a peripheral speed of about 7,000 feet per minute may be used. Such discs are used in separating tubing and cane into shorter lengths to facilitate handling and for the removal of sprues from rough glass articles made in font molds.

A small amount of surplus glass may be removed by grinding on a cast iron plate rotated on its vertical axis, the plate being fed with an abrasive such as silica, carborundum, etc., in water. In the case of plate glass or where a number of small articles are to be ground to a plain surface the glass is set in plaster on a table and the grinding discs work over this table.

Recently there has appeared on the market a machine for surfacing small articles of glass that employs a thin disc composed of an abrasive bound in a resinous material. This machine literally saws off the excess glass, leaving a remarkably smooth finish of about the texture of a short finished stone polish.

The production of an opening in an article of glass is often the cause of considerable difficulty. Should a round opening be required and the surface of the article be substantially plain the hole may be drilled by means of a short length of steel or copper tubing held in the chuck of a sensitive drilling machine, the drill being fed with a paste consisting of an abrasive and water. In an emergency a small hole may be drilled by means of a steel bit moistened with turpentine, camphor or a mixture of the two.

In the case of pressed ware the holes may not only be located but the work of drilling lessened by providing projections on the mold parts to produce indentations in the glass at the points where the holes are desired. Often the hole is of sufficient size to make the use of the "knock out" possible. The knockout is obtained by building the mold to produce a thin section of glass just inside the desired opening. When properly made this thin section will give way when the intervening glass is given a sharp rap. The edge of the opening is then finished by reaming or grinding.

Holes are made in blownware by means of sharp flames directed on the glass at the points where the openings are desired. The surface tension with the flame pressure causes a hole to form and the glass to withdraw in the form of a beaded ring around the opening. Another more complicated method produces a hole having a neater finish. This method consists of heating a spot, and then by means of blowing pressure from within or a suction from without extending the hot glass to blowover thinness. This thin glass is brushed off and the edges finished by fire polishing.

A few years ago there was quite an agitation for a non-refillable bottle. While the idea never grew to commercial success some of the suggestions were interesting. One of these consisted of placing a constriction in the neck of the bottle and putting enough strain in the constricted section to make it possible to remove the upper section of the bottle neck by giving it a sharp rap. The upper section of the bottle neck was sealed with a material that could only be removed at great expense if at all.

Zirconium

The Bureau of Mines, Department of Commerce, recently issued Information Circular No. 6455 consisting of 30 unbound process-printed pages treating most comprehensively of all phases of zirconium and its uses. The use of zirconium and its compounds was largely experimental before the World War and was confined almost wholly to Germany and Austria. In 1920 the lowering of the price of zirconium metal powder stimulated production. In 1924 the Titanium Alloy Manufacturing Company introduced in this country a new opacifying agent, "Opax," made from zirconium. The lower price enabled producers to compete with tin oxide in the pottery trade. By 1928 the use of zirconium was steadily increasing in the manufacturing of brick, crucibles, and other refractory products such as high temperature cement.

A description and the properties of the material is given. Zirconium oxide and its properties are also covered. A chronology traces the history of the element and cites the progress made since Klaproth discovered the oxide zirconium in 1789. The industry is still in its infancy, its widest application at the present time being its use as a refractory material. The second most extensive use, it is claimed, is that of the oxide as an opacifying agent especially to enamel ware. It is also used as an opacifier in lacquers and automobile enamels.

Zirconia (the purest zirconium oxide) and zirkite (the native Brazilian oxide or a semi-manufactured form) are employed as refractory material, details of its use in brick, cement, laboratory ware, etc., being given. However, because of its cost, zirkite is generally substituted for large industrial uses.

USE OF ZIRCONIUM IN GLASS

As an opacifier in enamels as well as a clouding agent in glass, zirconia is an excellent substitute for stannic oxide, antimony oxide and others. As a result of investigations in Germany, a number of proprietary compounds of zirconium oxide mixed with certain fluxes have been placed on the market, and many foreign patents have been issued covering the use of the oxide in white enamels for steel and cast-iron utensils.

The subject of zirconium alloys is treated at considerable length. Zirconium-bearing minerals are tabulated. The occurrence of zirconium and zirconium ores is discussed. The production, mining and concentration, preparation of the oxide and methods for the separation of iron and zirconium necessary for the purification of zirconium compounds are given. The separation of titanium and zirconium, and of zirconia and silica, and zirconium from titanium and tin ore is also described. Methods for the preparation of zirconium in various other forms are stated.

The Manufacture of Rolled Plate

By ERNST LUTZ *

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

(*Continued from the February, 1932, issue*)

THE old method for placing large sheets of glass on the grinding table, involving the use of wedge shaped boards, caused the breakage of many large sheets. With finished sheets the insertion of the wedge boards very often caused scratching and spoiling of the polish by reason of small glass splinters coming off from the sheet edge and being pushed underneath along with the board. This drawback was somewhat lessened, but of course not fully eliminated by the custom of using for either side sheets polished on both sides, piercing boards lined with cloth. Before inserting these boards the sheet with the aid of wooden or soft iron knives was somewhat freed from the plaster or from the underlying cloth.

This procedure was started from the outer edge of the sheet and as soon as it could be slightly lifted a string, of 3/8" to 1/4" diameter and consisting of wool or cotton-wool or made up of cloth, was put underneath and then by its protruding ends further drawn beneath the sheet. The string was followed by the piercing boards. These latter, as mentioned before, not only very often caused a spoiling of the polish, but also the breakage of many sheets. In freeing and lifting with the suction crane both of the said drawbacks are almost entirely avoided. During the war and even for some time afterwards when German glass factories had no proper cloth and when one therefore had to resort to poor thin cloth or even paper make up, which at even small stresses got torn or became soft, the suction cranes offered exceptional services for the setting of the large sheets. When inserting the piercing boards or at the slightest movement of a sheet this poor cloth got damaged and caused the local formation of knots and long pleats; this of course forced the sheet to lie hollow and to break during the grinding of its second surface. With a suction crane, on the other hand, the sheets can be placed vertically down on the table, so that the cloth is not stressed in any way and can neither form knots nor pleats. All these advantages of the suction crane are particularly apparent in the tipping over of a table charge, which is finished-polished on its upper side and has to be removed.

For the turning over of the sheet, frames as shown in Figs. 177 and 178 or even ordinary tipping tables were used. When the sheet has been lowered by the suction crane on to the turning frame, the latter is put on edge so that the sheet comes to rest on two wooden blocks lined with felt; in this position the sheet is fixed whilst the turning frame is moved to its opposite side and then together with the sheet tipped down; the polished side now faces downwards. When stationary tipping tables are employed, the sheet has to be carried aside turned with winch and clamp, moved back and placed with its polished side against the dipping table. This work proceeds faster and simpler if the double winged tipping table as shown in Fig. 190 is used; both wings can simultaneously be put vertically, so that at its vertical position the sheet simply has to be pushed from one wing over to the other; with one wing it has been moved up, with the

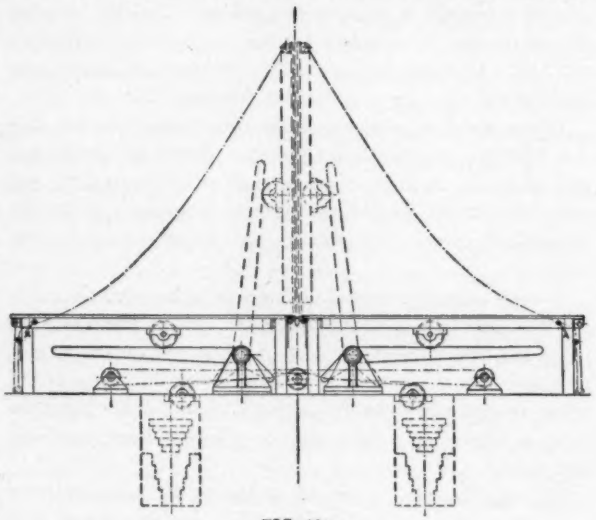

FIG. 190

other it is lowered again For a still better tipping device which takes up less space, the U. S. A. Patent 1,371,868 has been granted to the St. Gobain Co. According to the specification a frame a (Fig. 191) can be turned round two bolts b,b lying in its axis. This frame carries a grid c and a counter grid d; the rods of these grids are movable so that the top grate can be opened for the insertion and withdrawal of the sheet a. The Belgian patent specification 236,669 of Paul Uellner describes an arrangement where suction frame and tipping table hang on one and the same bridge crane (Fig. 192). The suction apparatus can move right into the tipping machinery, so that every part of it is within reach of the suction frame.

In recent times large sheets have been tipped over by the suction crane alone and without the use of any tipping table at all (see Fig. 193). For this purpose a two-row suction frame is employed, equipped with so many suckers that it is capable of carrying the sheet in its vertical position. In this case the suspension of the suction frame must be so arranged that when gripping a sheet it can form almost a

*Of Desseau, Germany. This work is appearing in German in the new edition of *Dralle-Keppeler*, "Die Glasfabrikation."

FOOTNOTE: In the Figures, originally prepared for use eventually in the new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (*m*) and millimetres (*mm*). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre.—F. W. P.

right angle with the sheet. A suction frame of this design of Pilkington Brothers, Ltd., in St. Helens, England, is described in the U. S. A. Patent Specification 1,426,692.

THE MAXIMUM OUTPUT

The maximum output of a grinding and polishing shop depends in the first instance on the capacity of the individual grinding and polishing machines as well as on an undisturbed sequence in the movement of the grinding tables. This latter must proceed in such a way that a new table is ready for every apparatus before the one in work is finished. The maximum output of grinding apparatus, as mentioned before, depends mainly on the flatness of the rough glass sheets and on their resistance to pressure and shocks, i. e., on their annealing, it also depends on the way the sheets are laid on the grinding tables, on the hardness, sharpness and grain size of the grinding sand at disposal, on the structure

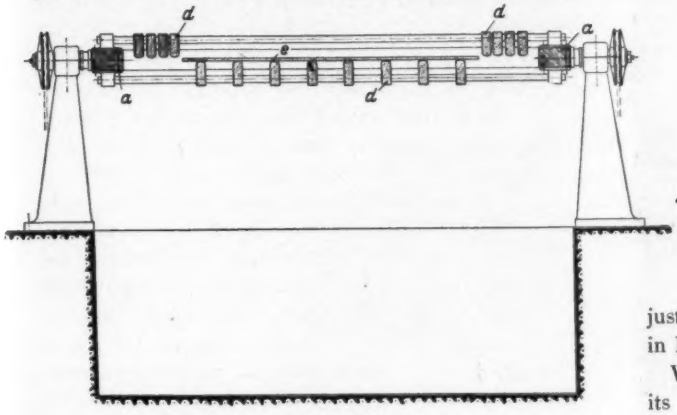

FIG. 191

of the runner cast-iron, on the favorable distribution of the runner irons over the grinding discs, on the proper distribution of the sand over the whole sheet and on the proper grading of the late sand and emery for the fine grinding The maximum output of a polishing apparatus depends on the nature of the preceding fine grinding, on the design of the polishing machines themselves and on the skillful handling of the rouge.* It must, however, be stressed again that serious defects in the fine grinding can not be removed by polishing.

As was previously said, the outputs of various factories differ appreciably. The figures given below are good average results for large machines. According to these figures the grinding and fine grinding of one side of a sheet setting takes about one hour and 20 minutes inclusive of 6-10 minutes for the changing over of the tables; a grinding machine thus evidently works 18 sides in 24 hours, which means nine table settings on either side. A polishing apparatus as shown in Figs. 155-157 requires 1¼ hours for the polishing of one side; for the change over of the tables and inspection of the polishing felts 15 minutes must be reckoned with, so that with such an apparatus 6 table settings can be finished-polished on both sides in 24 hours. However, with the apparatus illustrated in Figs. 158 and 159, seven table settings, and with the machinery shown in Figs. 160 and 161 eight table settings can be worked in 24 hours.*

For a given number of fully employed grinding machines the number of polishing machines listed in the following table is required:†

Number of grinding machines	1	2	3	4	5
Polishing machines according to Figs 155-157.....	2	3	5	6	8
Polishing machines according to Figs. 158 and 159.	2	3	4	6	7
Polishing machines according to Figs. 160 and 161.	2	3	4	5	6 etc.

In the interest of a lively run of the work the number of polishing machines should not be chosen too small, but should be rather kept on the ample side, as is the case in the above table; particularly so, if the production of a larger quantity of silvering quality is desired. If this latter point does not come into consideration then it may suffice to choose

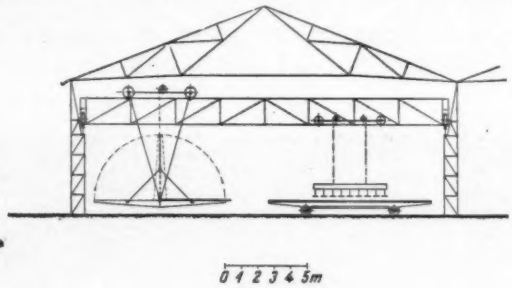

FIG. 192

just as many polishing machines (of the design illustrated in Figs. 160 and 161), as grinding machines.

With a good setting of the grinding table about 87% of its whole surface is covered with rectangular rough glass

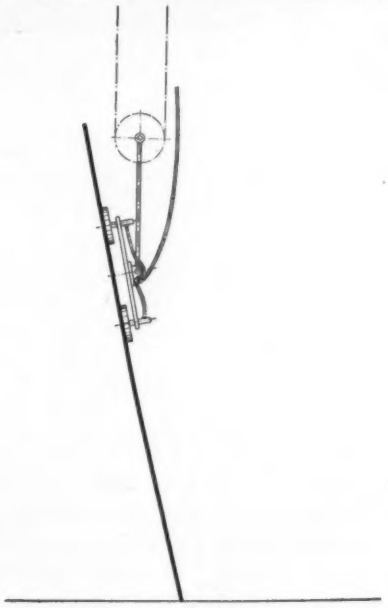

FIG. 193

sheets of over 4 sq. ft. size from the triangular pieces when finished-polished, also, oblong sheets are cut. If of the polished and cut sheets, ready for sale, all down to a size of

*Rouges differ among themselves, and need different treatments in the polishing operation, a matter calling for experience and skill on the part of the operator. This is true of rouges whereof it cannot be said that one is better than another. But some rouges are poor at best.—*F. W. P.*

*Between nine and ten would be nearer average American practice.—*F. W. P.*

†European practice.—*F. W. P.*

1 sq. ft. but not smaller ones, are considered as output of the factory, it may be considered as a good average, if, of the whole rough glass setting, including, as mentioned before, only sheets above 4 sq. ft. size, 85% reach the marketable state; that is, on an average, 74% of the whole surface of the grinding table. Of the 15% of the setting which is lost, about 9% is accounted for by breakage in grinding, polishing, setting, taking off and transport, 6% by the cutting during sorting, by the cutting for the removal of glass defects and by the breakage in the wareroom and in packing. The loss caused by imperfect glass which has to be cut out, naturally depends very much on the quality of the sheet as supplied from the casting hall, on the requirements regarding glass quality, and whether more or less sheets for silvering are required for the market.

Of the uncut rough glass sheet, i. e., of the surface rolled on the casting table about 80% remain as oblong cut sheets and about 68% of the said rolled surface is obtained in the form of marketable polished plate glass of over 1 sq. ft. size.*

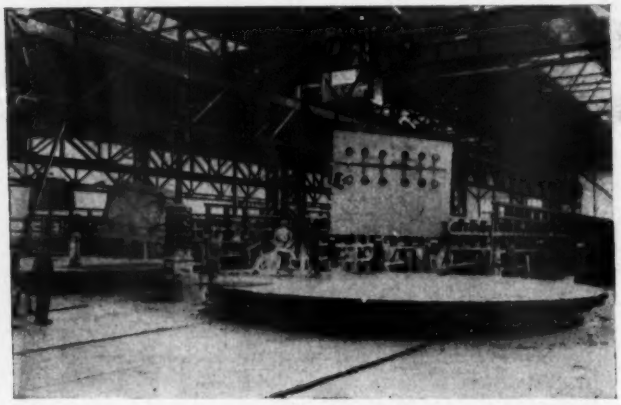

FIG. 194

The following table gives an average of a good net production of marketable polished plate glass per melting pot and per melting furnace with 16 pots for the three most commonly used lehr sizes:

Lehr Size No.	Content of a Pot When Brimful, Cu. Ft.	Output in Oblong Cut Rough Glass Sheets Per One Casting Process and One Pot, Sq. Ft.	Net Output of Marketable Polished Plate Glass in Sheet Sizes of 1 Sq. Ft. and Upwards: Per One Casting Process and One Pot, Sq. Ft.	Per One Casting Process and One Furnace, Sq. Ft.	Per One Furnace and 305 Casting Days Per Year, Sq. Ft.
I	22 to 24¼	237	201	3216	980,000
II	26½ to 30	318	270⅓	4325	1,320,000
III	35 to 37	377	320½	5128	1,560,000

A grinding table of 33 ft. diameter,† according to these figures, allows a rough glass setting of about 732 sq. ft. and a net output of about 622 sq. ft. If on one grinding machine 9 to 10 layings are worked on both sides in 24 hours, this evidently corresponds to a daily net production of 6,000 sq. ft. of plate glass, and assuming 305 working days, of about 1,830,000 sq. ft. per annum.

The figures of output given above and for a certain production of rough glass, i.e. for a certain number of melting furnaces in commission, depending on the pot and lehr sizes, allow the calculation of the required number of grinding and polishing machines. The figures given as good average outputs of this machinery also allow for occasional short shut-downs as will happen in all factories; with regard to this latter point it is desirable to be on the safe side, it suffices however if 5 to 10% of the net production calculated from the given grinding and polishing outputs are taken off; today the keeping of stand-by or reserve machinery under normal conditions is not necessary as long as sufficient spare parts are kept in reserve, so that individual components of the apparatus and of their drives can, if required, be replaced at once.

The diameter of the grinding tables, theoretically speaking, could be increased (with equal r.p.m.,) until the sheets near the table edge are almost in danger of being thrown off by centrifugal force. If the number of revolutions should be lowered, the grinding and polishing output, as calculated on the number of finished worked glass settings, would be reduced. It must further be born in mind that the table weights increase at least with the square of the diameter, so that with large diameters extraordinary masses have to be moved; the wheel pressures exerted by the tables and traverse tables require special rail designs, the grinding and polishing apparatus must have excessively strong foundations and the king-shafts have to be made longer. Also the excavations for the machinery become deeper and the ground water conditions play a more important part. On the other hand, with an equal number of revolutions, the production per unit of time is of course increased. Most factories have tables of about 33 ft. diameter and the experience gained has taught that this size could be increased; however on the question of how far could be gone safely when maintaining equal r.p.m. no practical experience is available*

The capacity of a grinding and polishing shop with rectangular tables arranged in a straight and continuous line is determined by the width of the tables and their travelling speed, by the proportion of the table area that must be deducted for the plaster joints, by the number of tracks, and by the loss through breakage (shrinkage). The travelling speed of the tables depends on the length of the line, i. e. on the number of grinding and polishing heads. The more extensive the line and the more machines installed, the faster may be the speed. Where sheets of a single size are to be set, as for example with the Ford Motor Company, the gaps constitute a very small loss of area. If, however, sheets of various dimensions are laid on the tables, the total space occupied by the gaps and by small pieces of glass of no value may make up to 5% of the total surface of all tables. (With circular tables, one has to figure on 12-15%).

As an example one may suppose 2 grinding and polishing lines the one working the first side of the sheets, the other working the second side; the useful table width is 15 ft., the travelling speed 170 ft. per hour, the loss of area due to the joints and worthless pieces of glass 2.5%, the loss through

*It seems well to have these figures of European practice as reported by Lutz; they will serve American manufacturers as a comparison. The American way of figuring is somewhat different, and the "shrinkage" is higher with round tables and lower with continuous tables, than given on this page.—*F. W. P.*

† Ten metres European standard. American desks are 36 ft. and English over 35 ft.—*F. W. P.*

*This point is now of academic interest only as development is centered entirely on continuous machines.—*F. W. P.*

breakage and cutting—the latter depending on the standard of a certain quality required for the glass—8% of the total glass surface; an allowance of 1 hour per day should be made for more or less inevitable interruptions. This grinding and polishing plant would then produce a daily output of 23 . 170 . 15 . 0,975 . 0,92 = about 52,600 sq. ft. of polished plate delivered to wareroom. If one figures 305 operating days per year for pot furnaces the above plant should yield 305 . 52,600 = about 16,000,000 sq. ft. per year.

As a traveling speed of 170 ft. per hour is a relatively slow one, it can be well figured from this example how extraordinary is the capacity of straight continuous lines as compared to plants with circular tables. Naturally, their superiority cannot be so obvious if, as is the case in Europe, only a few pot furnaces are installed for feeding them, and the tables, consequently, need not travel very fast, and perhaps can only be operated at intervals.

more apparent than in windows. It may, however, happen that sheets which, regarding purity and size, are selected for first choice require a polish which is beyond the ordinary requirements. If these sheets do not meet such special requirements they are again polished on special polishing machines. Fig. 195 shows such a machine as designed by H. A. Waldrich G.m.b.H., Siegen i/W. and Fig. 196 a similar but larger machine of the S. A. A. Simon, Andenne. The polishing table on which the sheets are lying, moves to and fro while the polishing blocks which are lined with felt and covered with rouge, carry out an oscillatory movement, derived from cranks. Small shortcomings of the polish as well as light scratches can be removed with polishing machines as illustrated in Fig. 197; deep scratches, however, can only be got rid of by the prolonged rubbing of the corresponding spot with the aid of a wooden polishing block, covered with felt and operated by hand; this process is limited by the fact that after a while a local hollow will be

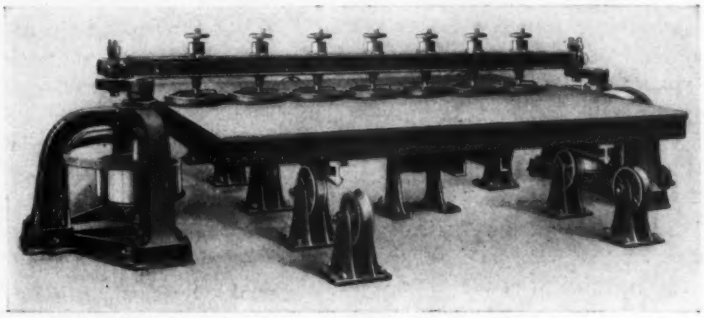

FIG. 195

The large polishing machinery works the sheets to such a condition, that with ordinary light, the naked eye can no longer discern the inequalities of the fine grinding, even if the back is silvered; the glass in this condition should have a fine dark lustre. As it is rare that the polish of the whole table charge is of equal quality, an attempt must at least be

produced, which even in windows spoils the aspect somewhat and in mirrors will cause distortions of the image. Such extra polishing and auxiliary machines are usually erected in the immediate neighborhood of the wareroom; B in Fig. 125.

The wareroom is usually so laid out that it can hold the

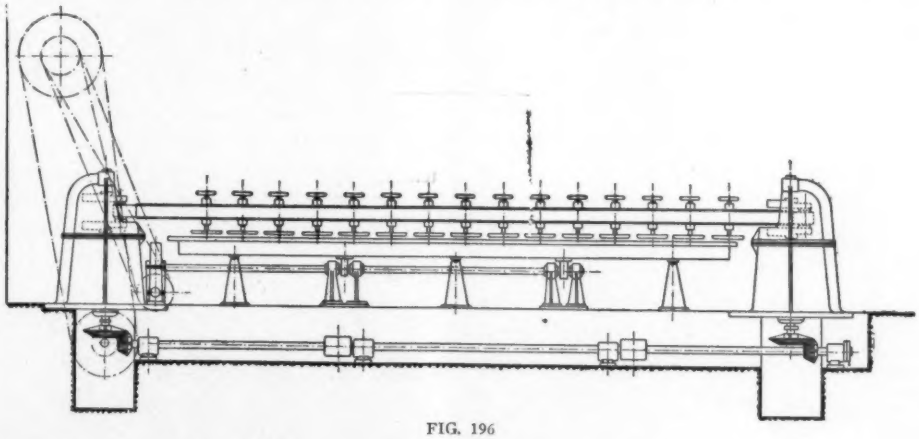

FIG. 196

made, that even the less perfect parts fulfil the requirements for silvering purposes. If this is attained, one has at the same time the certainty that the polish of all sheets intended for glazing purposes, shop windows and s. o. is sufficient, because with silvered sheets possible defects of polish are

production of 1 to 2 months. Special care must be given to the strength of the racks for the large sheets, and the figures 198 and 199 show a construction of steel channels. The stands of one row are connected with each other by wooden boards against which the sheets lean. The vertical com-

ponent of the weight of the sheets is taken up by channel-irons b, which are riveted on to the vertical iron stanchions so that the whole construction forms one unit which cannot fall, even if only one side is filled up with sheets. Practical stands may be made of wood. The vertical pillars are stiffened at their upper end by a cross beam. In racks for large sheets the distance from one centre to the other is 8½

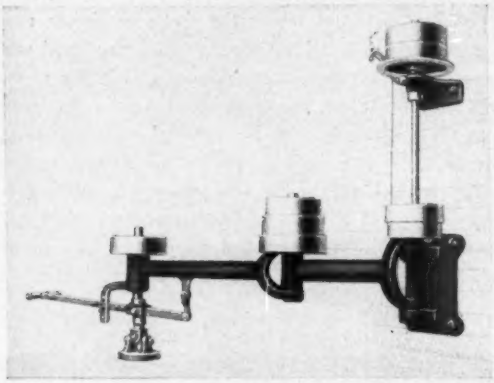

FIG. 197

feet if the sheets are removed by hand; however, if overhead cranes, monorail and the like are at disposal 6½ feet suffice.

GRINDING AND POLISHING SHOP FORCE

The tabulation below includes sand grading, wareroom, packing room and box shop but excluding yard workers, power house, repair shops and the like. It assures three 8-hour shifts for the grinding and polishing and one 8-hour shift in the examining, wareroom and packing room. The grinding tables are supposed to have a diameter of 33′, and the polishing apparatus to be designed as illustrated in Figs.

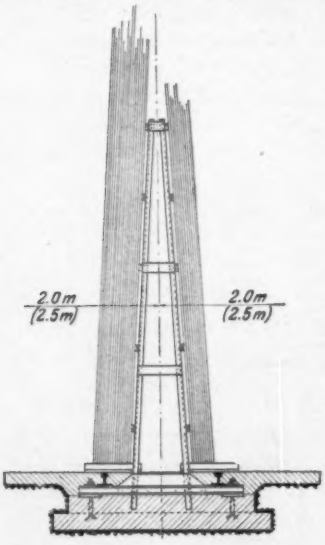

FIG. 198

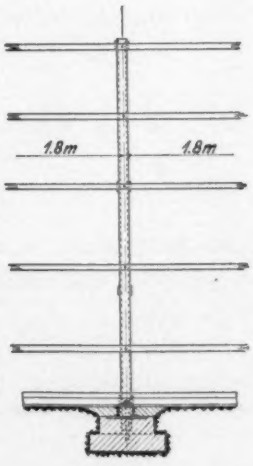

FIG. 199

160 and 161. For the transport of the large sheets clamps and vacuum frames, and for lifting of the grinding sand on to the grinding table mammoth pumps, emulsifiers or rotary pumps as illustrated in Fig. 125, are supposed to be available.

	For an Output of Polished Plate Glass Per Annum of		
	Sq. Ft. 2,100,000	Sq. Ft. 4,200,000	Sq. Ft. 6,675,000
Number of grinding machines..	2	3	4
Number of polishing machines..	2	3	5
	Number of People Per 24 Hours	Number of People Per 24 Hours	Number of People Per 24 Hours
Works manager	..	1	1
Foreman	1	1	1
Assistant foreman	3	3	3
Writer, clerks	5	8	11
Laying, turning and stopping:			
Foreman	3	3	6
Preparing	4	6	8
Laying	27	48	69
Preparing of plaster	3	3	6
Cleaning of clothes.....	4	6	8
Crane operators	3	9	9
Cleaning, cullets, etc.	3	5	6
Grinding:			
Grinders	4	7	11
Second grinders	4	7	11
Grinding sand	3	3	3
Grading fine sand	3	3	3
Emery	1	1	1
Runner bars	3	6	9
Polishing:			
Preparing	9	15	24
Polishers	4	8	13
Rouge, felts	1	2	3
Foremen for grinding and polishing	3	3	6
Transfer tables, table-moving locomotives	6	9	12
Supervision of mechanical and electrical apparatus	4	4	6
Cleaning of the glass sheets.	9	15	21
Removing of the sheets to the inspection room.....	3	5	7
Settling ponds	4	6	8
Inspection, cutting, buffing, wareroom	29	48	68
Packing and shipping	8	12	18
Box-makers	3	5	7
Sum total	157	252	359

If one takes the above shop with circular tables and another one with wide rectangular tables, i. e. with a straight and continuous grinding and polishing line adaptable for all sizes of glasses (Fig. 135E); and if one supposes that both of the shops were operated under the same conditions, the latter will save:

In column:	1	2	3
Preparation	1	3	2
Laying	3	6	12
Crane operators	..	3	3
Grinders	1	4	8
Assistant grinders	4	7	11
Preparation for polishing	6	12	18
Polishers	1	5	7
Traverse tables, etc.	6	9	12
Number of employees saved.	22	49	73
Consequently personnel required:			
For circular tables	157	252	359
For rectangular tables	135	203	286

All of the three examples chosen here correspond to very small capacities of the straight and continuous lines. Where the annual output is larger, as is especially the case in North America, the savings of personnel by the use of continuous methods is far more obvious.

(To be continued)

Glass Men and Ceramists Descend on Washington

Annual Meeting of American Ceramic Society

WASHINGTON is an attractive location for a meeting of almost any type of organization and visiting members of the Glass Division of the American Ceramic Society as well as its other divisions, together with the National Brick Manufacturers Research Foundation, took full advantage of their opportunities for sightseeing during the annual meeting of the American Ceramic Society, February 8 to 12. The week was marked by visits to points of interest, attendance at many interesting technical meetings, and numerous desirable social and business contacts were effected among those of mutually congenial interests.

One of the most popular features was the large Dance and Frolic held on Tuesday evening, February 9, under the auspices of the Materials and Equipment Division. It was attended by over four hundred persons. Many members took advantage of the trips that had been organized to visit Mount Vernon, the Bureau of Standards and other interesting places. On Friday, February 12 a number of members went to Baltimore, an hour's ride from Washington, and visited the plants of the Carr-Lowrey Glass Company, the Maryland Glass Company and a couple of enameling plants.

As announced well in advance of the meeting, the Society had been favored with an invitation for its members to attend the reception on the White House lawn to meet President Hoover, and at Wednesday noon a gathering of several hundred members of various divisions enjoyed the privilege of watching him proceed across the grounds to the point where the visitors had gathered and of being photographed in a group of which he was the center.

Those who had read that morning's Washington papers, however, keenly realized that they were participating in a ceremony not likely to be repeated many times, if at all, for on the same day the Washington papers announced a new rule—that all handshaking Presidential receptions were to be abolished on the ground that the greatly increased number of requests from Conventions for such receptions were seriously interfering with the President's official duties and making unreasonable demands on his time and vitality. As a matter of fact there was practically no handshaking on this occasion and it is probable that only one other Society, which followed the Ceramists the same day, has since been accorded even the privileges granted to the glass men and ceramists as the new regulation went into effect immediately.

SNAP SHOTS BY HETTINGER, THE SAFETY MEMBER

The Glass Division programs were carried out with few changes from the schedules given in the February issue. The Tuesday and Wednesday meetings especially were well attended. The papers presented were of high calibre type, reporting in a number of instances the results of painstaking and exhaustive research on the part of the respective authors. The most recent development disclosed in glass technology (referred to briefly editorially in the February issue) related to the application of diffusion combustion principles to the melting process, a principle already introduced on a practical scale in an Ohio glass plant and reliably reported to be in successful operation.

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STRUCTURAL CLAY PRODUCTS (Chairman) Amos P. Potts, Clay

THE PRESIDE

Products, Inc., Brazil, Ind. (Secretary) Marion W. Blair, 2131 S. Center St., Terre Haute, Ind.

TERRA COTTA (Not received as yet).

WHITE WARES (Chairman) H. M. Kraner, Westinghouse Electric & Mfg. Co., Derry, Pa. (Secretary) Louis Navias, General Electric Co., Schenectady, N. Y.

Materials and Equipment Division

The meeting of the Materials and Equipment Division of the American Ceramic Society was called to order at ten o'clock a.m., February 9, by Henry Kleinfeldt, acting chairman. Mr. Kleinfeldt reviewed briefly the aims and purposes of the Division and the relationship of this division to the American Ceramic Society at large.

In the absence of Mr. Peddrick, chairman of the Membership Committee, his report was read and made a part of the record. The reading of the report of Mr. DuBois, chairman of the Nominating Committee, was deferred until the following day. The report of Secretary-Treasurer Kelsey was not read at this meeting but it was agreed that it is to be written up and a copy mailed to each member of the Division.

Inasmuch as only a few members attended this meeting it was agreed that there would be another meeting of the Division to be held at ten o'clock a. m. on February 10. The meeting then adjourned for the day.

On February 10, at ten o'clock a. m., Henry Kleinfeldt called the meeting to order and thirty members were in attendance. At this meeting a great deal of enthusiasm was manifested by everyone and the following matters were discussed and action taken on a number of important matters.

The dance sponsored by the G.E. Division on Tuesday evening, February 9, at the Washington Hotel, was attended by more than four hundred and fifty persons and was enjoyed very much by everyone. This informal affair has done more to strengthen the position of the M.&E. Division than perhaps any other single activity.

Mr Kleinfeldt opened the meeting, and again outlined the plans and purposes of the M.&E. Division.

The report of the Nominating Committee was read by Mr. DuBois and it was moved by Mr. Crane that the present officers be elected by acclamation to succeed themselves, with the exception that Henry Kleinfeldt was elected chairman succeeding L. E. Riddle Jr. who asked to be relieved from that office. This motion was carried. F. G. Lord is again vice-chairman and V. V. Kelsey remains as Division Secretary.

Mr. Peddrick's report as chairman of the Membership Committee was read and approved and it was pointed out that during the year he was successful in reducing the Division's deficit by $165.

Mr. Burgess stated that the future success of the Division depends quite largely on the type of papers that are presented to the members of the Society at large. With this in mind Professor Brown was appointed chairman of the committee to solicit papers and to accept such papers as, in the opinion of his committee, would be interesting and suitable to present annually at the general meeting of the American Ceramic Society.

On motion by Mr. Metz, which was unanimously carried, a luncheon of the M.&E. Division members is to be held on the first day of the annual meeting.

Professor Brown suggested that a letter be sent to the entire membership of the A.C.S., calling attention to the fact

Greeting President Hoover on the White House Lawn

Glass Division and other members of the American Ceramic Society pay their respects to the Chief Executive. Ross Purdy on Guard at Rear.

that each member has the privilege of holding membership in more than one Division. Professor Brown also stated that it might be arranged for a division of membership funds in the case where a member holds membership in more than one Division.

It was proposed that the M.&E. Division secure permission from the Society to hold one general meeting at the annual conventions, at such time and place as would not interfere with the Society meetings; this meeting to be a general session under the supervision of the M.&E. Division. It is hoped that this can be accomplished. The foregoing was put in the form of a motion by Mr. Dressler and was seconded and carried.

On motion by Mr. Burgess, which was carried, it was agreed that a letter would be sent to the members asking for certain limited contributions, with the idea of wiping out the present substantial remaining deficit. In this letter plans would be outlined, describing aims and purposes of the M.&E. Division.

On motion by Mr. Metz, which was carried, it was agreed that the M.&E. Division will hold an annual dance and frolic for the entire membership, if this plan will not interfere with the plans of the Society at large.

A number of suggestions of a most constructive nature were presented by the following: Mr. Dressler, Prof. Brown, Messrs. MacKnight, Burgess, Weiss, Stanger, Lord, Metz, Nickerson, Ericson, Crane and DuBois.

American Versus English China

During the course of the meeting of the Materials and Equipment Division on February 9, Secretary Kelsey called the attention of the members present to a matter which he felt should be given serious consideration by all, including the glass trade, which may quite possibly find itself some day confronted by a similar situation.

He thought they would be interested in knowing that the Daughters of the American Revolution recently agreed to purchase commemoration plates from Wedgwood, an English pottery manufacturing concern. The purchase, we understand, was made through an importing company in Boston.

When it was heard that the Daughters of the American Revolution intended to ignore American china manufacturers by purchasing foreign ware, Mr. Kelsey addressed a letter to their headquarters at Washington, D. C., calling attention to the fact that there are a number of American

(Continued on page 53)

WAITING TO WELCOME PRESIDENT HOOVER SOCIETY OFFICERS SEEM PLEASED AT THE PROSPECT
President Eskensen and Vice-President Silverman

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The Flying Scotsman

THE grizzled skipper of the big green locomotive leaned thoughtfully by the side of the cab. In his gloved hand he held as usual a piece of rag with which, unconsciously, he rubbed the brass rod to which he clung, as if its polish might lack some perfection, and stared forward into the night. Behind him the long corridors of the night mail surged over the granite-ballasted bed, swaying gently on their perfect foundation.

The grimy fireman stood by the other side of the cab in a similar reverie as the great green engine took the "points" at the junction at seventy miles an hour and at a touch of the skipper's hand opened out for the long flats of the flood-plains at eighty-five.

Beneath him the moonlight danced upon the river; before him it shimmered on the polished brass-work of his beloved machine. The villages were all asleep. The gargoyles of old cathedral towers alone looked down on that comet of the night—a yellow stream of flying windows and a blood-red pennant of cloud above. And as they watched, the deep boom of the cathedral bells announced that the skipper was on time.

North where the sea broke at his feet, with the mountains overhead, by ghostly castles of feudal days and abbey ruins he sped, to meet—and—beat—the great blue engine from the west on the line beyond Tay.

When the green engine took the rails, the skipper had been with her. When she went into the shops, the skipper went too. He knew every repair that was made and how it was made and who made it, and he knew it was made right; and when she took the rails again, the skipper was at the throttle. And when the gargoyles looked down upon his bloody pennant, the ghosts of master architects looked down upon a master craftsman at the helm.

. . .

They have taken his engine from him. The efficiency men have decided it is not necessary for him to go into the shop when his engine goes in. He can drive whatever engine happens to be available, and other men can drive his engine if it happens to suit the railroad schedules. There is a *system* in the shops to make sure that the bearings fit within limits, but the brasswork is not, perhaps, polished so perfectly as once it was.

The skipper is an older man, grayer and quieter than before. As he leans by the side of the cab his eyes seem strained; there are unfamiliar sounds in the whirling steel-work of his unfamiliar machine and the boom of the big cathedral bell announces the knell of the skipper's era. For machines are no longer the tools of men, but their overlords; on them is erected the *system*.

. . .

You can buy the railroad's common stock—"ordinary shares" they are called over there—at twenty five cents to the dollar; the system has not saved it.

The skipper lies on a green hillside across the river from the old cathedral, and the gargoyles watch through the night for a light that appears above the cemetery hill and roars northward on the wings of the wind, a master craftsman in a

master machine, ferrying the night mail through the skies. And as they watch, the boom of the deep cathedral bell announces that the skipper's son is on time.

They will take his machine from him by and by; it is not in the interests of efficiency that the machine shall fly only with one pilot, or that the pilot should not fly when the machine is being repaired. Rationalization and Progress demand it; and you will be able to buy the airplane company's stock at twenty five cents to the dollar after a while.—*F. W. P.*

Magnetic Beneficiation of Nonmetallics

By SAMUEL GIBSON FRANTZ,* PRINCETON, N. J., AND G. W. JARMAN, JR.,† NEW YORK, N. Y.

(New York Meeting of American Institute of Mining and Metallurgical Engineers, February, 1932)

THE purpose of this paper is to relate briefly the development of magnetic separation and its extension from the separation of iron into its present use in the nonmetallic field, to suggest possible future extensions of its field of usefulness and its possible cooperation with other separating methods. The engineering design of separating machines, and statistics as to the number of machines in operation, types, their location and production are outside the scope of this paper. Specific data will be given, however, on certain selected applications.

A large part of human endeavor consists in separating one thing from another; the good from the bad, the desired from the undesired. In fact, a philosopher might plausibly claim that separating things into categories and choosing between them is the object of thought itself. In dealing with matter, separation is nowhere more inherently necessary to attain our objects than in mining and metallurgy.

Both our desire and our ability to make separations are results of the physical differences between things. Gross separations such as removing ore from worthless rock or coal from slate are usually made visually and depend upon form and color, which are physical properties. When the desired and the undesired things are intimately mixed, however, it becomes impractical to select visually even if the individual particles are readily recognizable to the eye, and some automatic way of making the particles separate themselves on the basis of their own inherent differences in physical properties must be resorted to. Some of the physical properties which have been used as a basis of separation are: color, shape, hardness, size, density, elasticity, surface properties (surface tension in contact with liquids, etc.), electrical conductivity, dielectric constant, and magnetic susceptibility.

Differences in these properties are used in the following methods of separation: color sorting, sifting, settlement in air and in liquids, float-sink methods, flotation, electrostatic and magnetic separation.

DEVELOPMENT OF MAGNETIC SEPARATION

Although the ancient Greeks were familiar with some of the phenomena of magnetism as early as 550 B.C., and though the Chinese used the compass according to authenticated references as early as 121 A.D., it was not until 1845 that Michael Faraday discovered that all substances were susceptible in a varying degree to the influence of a magnetic field. Edison, Wetherill and others applied this to the separation of iron ore from a gangue and carried the process further in the successful separation of some strongly magnetic minerals; they differentiated between "feebly magnetic" and "nonmagnetic" materials. The feebly magnetic were described as substances that an ordinary magnet would not affect perceptibly but which could be influenced by a very strong magnetic field, while the great majority of minerals were classed as nonmagnetic.

Up to 1925 Faraday's discovery that no substances were indifferent to the magnetic field had not brought about the extension of magnetic methods of separation to materials of which the susceptibilities were so small that they were classed popularly as nonmagnetic. To appreciate clearly how this old division between feebly magnetic and nonmagnetic substances has been wiped away, it should be understood that the force on a particle is proportional to the square of the field strength and that an ordinary permanent magnet has a field strength of the order of 800 gauss (lines of force per square centimeter) while modern magnetic separators employ field strengths as high as 15,000 gauss.

Magnetic separation, like nearly all other separating methods, depends on the density of the particles as well as on the particular physical property characteristic of the method. In these methods all the particles are acted on by two forces, one of which is gravity. The other force is in a direction different from gravity and therefore the *direction* of the resultant force is determined by the *ratio* between the special force employed and gravity. Although the special force may be and usually has been upward, directly opposed to gravity, it may be partly or entirely horizontal.

In magnetic separation both vertical and horizontal forces have been used. The older machines in general were vertical force types; the newer and more sensitive machines employ horizontal forces. The ratio of the forces is

$$\frac{\text{Magnetic Force per Unit Volume}}{\text{Gravitational Force per Unit Volume}} = \frac{ck}{gD}$$

where k = magnetic susceptibility of the particle,

g = gravitational constant = 980 dynes per gram.

D = density,

c = a constant depending on the geometrical and magnetic configuration of the machine.

$\frac{k}{D}$ is called the mass susceptibility and is the single physical constant characteristic of the substance comprising the particle which determines its behavior in a magnetic separator. In other words, the pull on a particle is affected by the degree of concentration of the magnetic field and by its intensity; it also is proportional to the magnetic susceptibility of the particle; and the usefulness of this pull must be gaged by its relation to the pull of gravity. With non-ferrous substances the susceptibility is usually a very small quantity, of the order 10^{-6} (for example, quartz) and even is negative in a few rare cases; *e. g.*, diamagnetic substances, such as bismuth. These figures are to be compared with a susceptibility of the order of 100 for iron. Thus to obtain separations of nonmetallics, one from the other, it is in general necessary to employ very intense and highly concentrated fields, and to use the forces exerted by these fields in the most efficient way to get a physical separation into two grain streams. The latter requirement may be met by using the magnetic forces to deflect particles in a falling stream, where a force equal to only a small fraction of the weight of the particle is able to produce a useful deflection, rather than by attempting to lift the particles bodily against gravity.

About 1926, Fred R. Johnson, working in the research laboratories of The Exolon Co., devised a separator combining high magnetic field intensity with deflection of a falling grain stream. His machine showed remarkable results. It was able to make separations between two components, both of which were commonly considered nonmagnetic. His separation of biotite and muscovite mica from feldspar aroused great interest, which led to very active development work on the part of the company just mentioned and stimulated all the other builders of separators to the design of new and more sensitive machines. Muscovite mica and feldspar are two white materials which were both formerly considered nonmagnetic.

The U. S. Bureau of Mines refers to these cases in *Information Circular* 6488 (1931), as follows:

"The Johnson separators are of the electromagnetic induction type. Each machine has two large coils, an upper coil with three pole pieces at each end, and a lower coil with two pole pieces at each end. A laminated rotor, 30 inches long, revolves under each

* Consulting Engineer.
† President, Separations Engineering Corporation.

of these pole pieces. A special device feeds a thin uniform stream of the sized spar over the length of each rotor. As the material passes from one rotor to the next, all magnetic particles are deflected by the rotors, permitting the feldspar to continue on through five successive treatments. Each rotor removes a portion of the contaminating minerals, the more highly magnetic being removed by the upper rotors and the feebly magnetic by the lower rotors.

"The strength of the magnetic field developed by the Johnson induction separator is phenomenal, and as the separation depends on the deflection of magnetic particles in falling rather than on lifting, astonishing results are obtained, in that minerals even with traces of iron are removed. For example, muscovite without visible iron stain is removed from the spar which, prepared by this method, consistently contains less than 0.06 per cent of iron or about one-half of the usual maximum specification for this type of spar."

METHOD OF OPERATION

At present it seems necessary to keep the size of feed 8 mesh or below. If the screen analysis shows the grains to be very close together in size, such as sand, it is not necessary to screen more closely than by taking all the material that passes through the scalping mesh. However, in most instances it has been found that a better product is recovered if the—8-mesh material is sized to various divisions such as — 8 + 16, — 16 + 30, — 30 + 60, — 60 + 100, etc. In general it is more difficult to handle extremely fine sizes, nevertheless in one instance an air separation product of — 300 + 400 mesh is being treated.

In the new machines a thin stream of properly dried and sized ore is fed down a chute and over a rotor. The rotor is highly magnetized by induction by a pole piece which faces the rotor across its entire length; the surface of the rotor is laminated, having alternate areas of iron and non-magnetic material, so as to cause a concentration of the magnetic lines of force upon the iron surfaces of the rotor. It is this concentration which enables the magnetic field to act upon magnetic particles in the grain stream and to pull them towards the rotor surface, and good design in this respect is necessary to give the highest possible value to the constant c in the formula given above. The more highly magnetic particles in the stream are more deflected than the less susceptible ones and fall short of them, making two separate streams physically divided by a knife-edge spliting chute, which should have a calibrated setting. The stream that was less deflected is passed on over a series of rotors, each of which is progressively more highly magnetized than the last. The grain stream is split below each rotor, thus losing the particles that are sufficiently susceptible to be deflected by the stronger magnetic field encountered. Thus there is a magnetic fractionation of the original mixture and an end product is reached which contains substances that cannot or need not be separated further by magnetic means.

A feature of magnetic separation which is not found in most other methods is its ability to handle a wide variation of quality in the head feed without shifting splitter adjustments to any great degree. On a table, for instance, if an ore varies between 10 and 50 per cent rich, suitable adjustments would have to be made for this variation, while in this process the knife edge would not have to be adjusted and only a small difference in the purity of the concentrate would result.

The capacity of a machine in tons per hour is proportional to the width, thickness, velocity and density of the grain stream. The density, of course, is a property of the given material; the permissible velocity and thickness of the grain stream depend on the design of the machine and on the material, and in general are decreased with increasing difficulty of separation. That is, if the particles to be separated are very feebly magnetic, or if their mass susceptibilities are very close together, either the velocity or thickness of the grain stream, or both, may have to be reduced. Therefore, as might be expected, the capacity of a machine decreases sharply with the difficulty of the separation.

In a well designed modern machine for nonmetallic separation the magnetic field is intense, the value of c in the formula is high and therefore the pull on the particle is high. The fact that a stream is merely deflected rather than lifted makes even a small force effective to separate. For these reasons the length of time that the particles must be in the zone of the magnetic force to acquire an effective separating momentum is much shorter than in the older types of belt machines, where the forces were vertical and were less strong in intensity, so that the tonnage capacities of the modern machine are very much greater than were attained formerly. In one instance, working on the same ore, a modern machine is handling a tonnage per foot width of grain stream almost four times as great as a machine built prior to 1925. The capacity of the standard size of one modern make varies on nonmetallics between 1 and 5 tons of feed per hour, depending on the factors stated above.

An example of interesting separation is the removal of ash from coal. Laboratory tests have lowered the ash content of anthracite coal from 26 to 11.3 per cent with a 70 per cent recovery. The ash content of bituminous coal has been lowered from 10 down to 6 per cent with 92 per cent recovery. As another example, a kyanite of 98.7 per cent purity is produced by magnetic separation followed by electrostatic separation. The magnetic separator recovers 68 per cent by weight of the feed, giving a recovery of 81 per cent of value, with a tailing content of 4 per cent kyanite. An interesting phenomenon is that in some instances a better separation is achieved by using a less powerful field than would be thought necessary, and in fact better than a far more powerful flux would yield. This may not always be due to the fact that both materials being separated are thrown one way by the more powerful magnet, but may sometimes be explained by the necessity of using the greatest possible difference in mass susceptibility between the two particles. This may be found in a less powerful field, since the susceptibility is not always constant for all field strengths.

COST DATA

The cost of separation varies from about $0.07 to about $0.60 per ton of head feed. This variation is due first to differences in fixed charges, since the cost of a machine depends in part on the strength of the magnetic field which it must produce to separate the particular materials. If only low field strengths are required, as in separating ferromagnetic substances, the purely mechanical items preponderate in the cost of the machine, the copper and iron costs are low, and the power cost for energizing the magnets is small. However, for very feebly susceptible substances, large amounts of copper and iron are required in the electrical and magnetic circuits in order to produce strong fields. Machines have recently been built giving flux densities as high as 17,000 gauss. In such cases special iron must generally be used; also forced-draft cooling systems for the coils. One of the most recent advances has been in the direction of economy of electric power consumed. The latest designs operate on from 1 to 5 kw.-hr. per ton, depending on rate of feed and strength of field required.

Detailed data are not available at this time from all industries. However, it may be said that in one specific instance in a nonmetallic operation the following results are achieved per machine:

Tons per hour head feed	1.74
Tons per hour concentrates	1.62
Percentage recovery	93.86
Average percentage Fe_2O_3 in heads	0.12–0.15
Average percentage Fe_2O_3 in concentrates	0.045
Lowest Fe_2O_3 analysis in concentrates, per cent	0.036
Highest Fe_2O_3 analysis in concentrates, per cent	0.055

In the course of tests on different mineral mixtures, some peculiar effects have been found which cannot be clearly attributed to previously known causes. For instance, an ilmenite running to all intents and purposes equal to another ilmenite in size, shape and chemical composition is much more difficult to separate magnetically. It has been observed repeatedly that the magnetic susceptibilities of samples of the same mineral vary when there is no apparent reason for such deviation, except geographical origin. An interesting surmise is that these differences in susceptibility may be due to different proportions of isotopes of the same element in two samples.

In addition to the actual separating costs, there is also to be considered the cost of preparation, which, again, varies with the nature of the material. In general all substances must be dried to the point where the particles do not adhere to each other. They must, of course, be ground down to the releasing point. Naturally, no material homogeneously mixed can be separated by a physical process. It must be a mechanical mixture, and that mixture must contain particles of such separate size that they can be released before grinding down into uneconomical minute sizes. For instance, if sugar is placed in dough there is a mechanical mixture, but the resultant mass must be ground down so fine that it cannot be ground economically. In difficult separations, where it is neces-

(*Continued on page* 53)

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potters who are fully qualified to deliver commemoration plates of high quality at reasonable prices and that if the organization should place an order for such plates with an English manufacturer, especially during these depressed times, the action would justly be open to criticism. Included in the letter were the names and addresses of over a dozen pottery manufacturers in the United States who were suggested as being competent to supply the organization's requirements satisfactorily. A suggestion was also made that representatives of the Daughters of the American Revolution call at the Wakefield Memorial Society at Washington and ask permission of Mrs. Rust, the president of that Society to inspect the Wakefield plates prepared especially for the Society by Lenox, Inc., of Trenton, New Jersey, and that a Lenox representative would be glad to meet the persons in charge of the matter at their convenience. This letter was dated January 22 and a reply dated January 23 was received by the Consolidated Feldspar Corporation with which Mr. Kelsey is connected.

The following excerpt speaks for itself:

> "We are very proud of the china made in our own country, and at the time would have been very glad to have accepted an offer of American made china, but no offers had been made and I must confess that I did not realize our American firms could make the pictorial china."
>
> "As a whole, our organization believes in American made goods for American people, and I am very glad to place your letter in the files for future reference."
>
> "Probably one interest we have in the firm of Jones, McDuffee and Stratton through whom we are negotiating, is that a daughter of Mr. McDuffee was very recently one of the National Officers of our Society and we have learned to think of this china more through the American firm than through the manufacturers themselves."

This letter bears the signature of Mrs. Lowell Fletcher Hobart, President General, N.S.D.A.R. Its receipt was acknowledged on January 25th by Mr. Kelsey, as follows:

> "We thank you for your kind letter of January 23rd regarding your Society sponsoring Wedgwood Memorial plates.
>
> "May we ask that you consider American made commemoration plates, and we shall be glad to assist you in every way we can in this connection.
>
> "For your information, some of the finest china made anywhere in the world is produced in this country. As a matter of fact we offer as our personal opinion that there is no foreign-made ware that is superior in any respect to some of the domestic made ware. Perhaps the American manufacturer has been a little too modest in exploiting his product, however in closing let us assure you that American chinaware today can be had equal to or perhaps in some instances superior to any of the foreign wares.
>
> "Again thanking you for your interesting letter, we are,
>
> "Yours very truly,
>
> "(Signed) V. V. KELSEY."
>
> "P. S.—During the week of February 8th there will be held in Washington at the Willard Hotel a meeting of the American Ceramic Society. While this is a technical Society it is none the less interested in the production and sale of American made pottery."

Mr. Kelsey also reported that he had received a number of letters, one dated January 28, 1932 from the Scammell China Company of Trenton, New Jersey and one dated January 26, 1932 from Mayer China Company, Beaver Falls, Pa. In his letter, D. William Scammell, of the first mentioned company, wrote Mr. Kelsey that when the matter first came to the attention of the Scammell China Company it was taken up with Mrs. Jennie Scudder Murray of, Trenton and Mrs. Hobart at Washington.

In view of his effort, Mr. Scammell intimated that he was of the opinion that the Daughters were not entirely frank in the matter as he understood that the question had been settled quite a long time earlier and in his opinion no chance was given to any American plant to quote on the organization's requirements. This, Mr. Scammell stated was naturally very discouraging inasmuch as his company had made the plates for the 250th anniversary of the city of Trenton and they thought there was no doubt that the Historical Society would give them consideration whenever there might be a demand for historical or commemorative plates.

Another letter mentioned by Mr. Kelsey was from Walter S. Mayer, vice-president of the Mayer China Company, Beaver Falls, Pa. We quote from Mr. Mayer's letter as follows:

> "It may interest you to know that we tried to sell this organization the plates and in reply we received a letter very similar to the copy which you enclosed. In fact several of the phrases used were the same. They have also placed our letter in their files for future reference, and we hope in one hundred years hence future generations of American potters can at least have the privilege of supplying these plates, if wanted at that time."

The plates under discussion are to be decorated with pictures of Mount Vernon, Washington Crossing the Delaware, and ten other scenes commemorating early American history.

(*Continued from page 52*)

sary to eliminate all possible interference with the very small magnetic forces developed on the particles, rather close sizing must be done to avoid the differential effects of air friction on particles of different sizes. These costs of grinding, drying and sizing usually will exceed the cost of separation.

FUTURE OF MAGNETIC SEPARATION

In looking at the future of magnetic separation, we should bear in mind that it will be used as it is now being used, sometimes alone as a self-sufficient means and sometimes in conjunction with other methods to accomplish results impossible or uneconomical by any single means. It is reasonable to believe that research both in the design of machines and in their applications will continue in the next five years as rapidly as it has in the last five and make the magnetic method one of the most important tools in ore dressing.

The use of this new process is of particular interest to the ceramic industry for the removal of faintly iron stained particles from their bodies. It is also of interest to all producers of nonmetallic materials such as bauxite, coal, fluorspar, kyanite, barite and the rare earths, etc. It would be well worth while for research engineers to look again into separating problems that have been given up as hopeless.

The magnetic separator is a dry concentrator; it is automatic, it is not dangerous, it is not affected by weather, its operation is simple, its cost per ton is low and its results are uniform.

A Remarkable New Protected Metal

According to a recent research report by Dr. A. W. Coffman, a new protected metal called "Robertson-Bonded Metal" (R-B-M) has been carried through the laboratory stages of development at Mellon Institute of Industrial Research. Copies of this report, giving complete information concerning this new material, may be obtained by applying to Mellon Institute, Pittsburgh, Pa.

It is a laminated material, the outer surfaces composed of felts, using a saturant chosen with reference to corrosive conditions.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

APPARATUS FOR MAKING GLASS. U. S. 1,834,631. Dec. 1, 1931. Vergil Mulholland, West Hartford. Conn., assignor to Hartford-Empire Co., Hartford, Conn. Filed 12/5/28.

APPARATUS FOR WORKING MOLTEN GLASS. U. S. 1,834,478. Dec. 1, 1931. Leonard D. Soubier, Toledo, O., assignor to Owens Illinois Glass Company, Toledo, O. Filed 5/25/28.

GLASSWARE FORMING MACHINE. U. S. 1,834,384. Dec. 1, 1931. Albert N. Cramer, Toledo, O., assignor to Owens Illinois Glass Company, Toledo, O. Filed 12/14/27.

GLASS CUTTING APPARATUS. U. S. 1,834,143. Dec. 1, 1931. Robert P. Callard and John H. Moller, Charleston, W. Va., assignors to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 5/3/26.

GLASS DRILLING MACHINE. U. S. 1,833,898. Dec. 1, 1931. Edward H. Hansen, Chicago, Ill., assignor to Johnson Fare Box Company, Chicago, Ill. Filed 7/12/23.

METHOD FOR CUTTING SHEET GLASS. U. S. 1,834,120. Dec. 1, 1931. Robert P. Callard and John H. Moller, Charleston, W. Va., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 12/20/28.

METHOD OF AND APPARATUS FOR THE MANUFACTURE OF SHEET GLASS. U. S. 1,834,656. Dec. 1, 1931. Arthur E. Spinasse, Mount Vernon, O. Filed 6/18/27.

PROCESS AND APPARATUS FOR PRODUCING SHEETS OF GLASS. U. S. 1,842,511. Jan. 26, 1932. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 1/12/28.

GLASS. U. S. 1,842,772. January 26, 1932. Zoltan von Veress, Budapest, Hungary, assignor of one-half to Rudolf von Kreybig, Budapest, Hungary. Filed 10/25/27.

MEANS FOR FEEDING MOLTEN GLASS TO ROLLING APPARATUS FOR PRODUCING CONTINUOUS GLASS STRIPS. U. S. 1,843,033. Jan. 26, 1932. Ernest Bristow LeMare, St. Helens, England, assignor to Pilkington Brothers, Ltd., Liverpool, England. Filed 12/18/30.

GLASSWARE FORMING MACHINE. U. S. 1,843,129. Feb. 2, 1932. John Ralph Hoge, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 9/12/29.

GLASS BLOWING MACHINE AND METHOD. U. S. 1,843,159. Feb. 2, 1932. Henry W. Ingle, Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 8/30/24.

GLASS BLOWING MACHINE AND METHOD. U. S. 1,843,160. Feb. 2, 1932. Henry W. Ingle, Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 10/14/24.

FLOWING GLASS. U. S. 1,843,178. Feb. 2, 1932. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 3/7/19.

METHOD AND APPARATUS FOR CONTROLLING GRAVITY ISSUANCE OF MOLTEN GLASS. U. S. 1,843,248. Feb. 2, 1932. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 4/7/26.

GLASS FEEDER. U. S. 1,843,249. Feb. 2, 1932. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 10/14/27.

GLASS FEEDING APPARATUS. U. S. 1,844,847. Feb. 9, 1932. Robert Good, Washington, Pa., assignor to Hazel-Atlas Glass Company, Wheeling, W. Va. Filed 3/24/26.

METHOD OF AND APPARATUS FOR DRAWING GLASS. U. S. 1,844,049. Feb. 9, 1932. Arthur E. Spinasse, Mount Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 3/27/24.

APPARATUS FOR MAKING COMPOSITE GLASS. U. S. 1,844,098. Feb. 9, 1932. William Orland Lytle, New Kensington, Pa., assignor to Pittsburgh Plate Glass Co. Filed 1/29/27.

METHOD AND APPARATUS FOR ANNEALING GLASSWARE. U. S. 1,844,154. Feb. 9, 1932. Robert Good, Washington, Pa., assignor to Hazel-Atlas Glass Co., Wheeling, W. Va. Filed 4/28/24.

GLASS FORMING MACHINE. U. S. 1,844,185. Feb. 9, 1932. Karl Schneegluth Amberg, Germany, assignor to Amberger Flaschenhutten A.G., Amberg, Germany. Filed 2/24/31 and in Germany 12/1/30.

GLASS WORKING MACHINE. U. S. 1,844,549. Feb. 9, 1932. Benjamin T. Headley, David Irvin Du Bois and Bernard H. Koeb, Millville, N. J., and Frank H. Lobb, Ridley Park, Pa., assignors to Whitall-Tatum Company, Millville, N. J. Filed 9/28/27.

APPARATUS FOR FEEDING GLASS. U. S. 1,845,491. Feb. 16, 1932. Fritz Eckert, Berlin, Germany, assignor of one-fourth to William A. Morton and one-fourth to Paul L. Geer, Pittsburgh, Pa., and one-fourth to Carl G. Hilgenberg, Baltimore, Md. Filed 4/25/28.

GLASS FORMING MACHINE. U. S. 1,845,525. Feb. 16, 1932. Theodore H. Sloan, Charleroi, Pa., assignor to MacBeth-Evans Glass Company. Filed 5/24/28.

GLASS MOUNTING FOR WINDOWS. U. S. 1,845,607. Feb. 16, 1932. Martin Katz, Brooklyn, N. Y. Filed 8/5/30.

PLATE GLASS STORE FRONT CONSTRUCTION. U. S. 1,845,610. Feb. 16, 1932. Louis Lamer, Ramsey, N. J. Filed 4/29/30.

GLASSWARE FORMING MACHINE. U. S. 1,845,626. Feb 16, 1932. Harold A. Rohrich, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 10/13/28.

APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,845,635. Feb. 16, 1932. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 2/18/28.

APPARATUS FOR CONDUCTING MOLTEN GLASS. U. S. 1,845,824. Feb. 16, 1932. Walter A. Amsler, Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 4/18/28.

APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,846,984. Feb. 23, 1932. Rene Arcq, Brussels, Belgium. Filed 12/26/30.

ANNEALING GLASSWARE. U. S. 1,846,566. Feb. 23, 1932. Vergil Mulholland, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Original application filed 10/13/25. Divided and this application filed 5/3/29.

GLASS TAKE-OFF MECHANISM. U. S. 1,846,503. Feb. 23, 1932. Lambert Von Reis, Herzogenrath, Germany, assignor to The American Bicheroux Company. Filed 4/18/29.

METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,836,358. Dec. 15, 1931. James C. Blair, Toledo, O., assignor to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 12/26/23.

SHEET GLASS GRINDING AND POLISHING APPARATUS. U. S. 1,836,364. Dec. 15, 1931. John L. Drake and Frank Fraser, Toledo, O., assignors to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 9/29/26.

MAKING GLASSWARE. U. S. 1,840,458. Jan. 12, 1932. Clyde R. Lott, Washington, D. C., assignor to The Owens Bottle Co., Ohio. Original application filed 9/27/09. Divided and this application filed 7/13/18.

METHOD AND APPARATUS FOR DRAWING GLASS IN CYLINDRICAL FORM. U. S. 1,823,543. Sept. 15, 1931. George E. Howard, Butler, Pa., assignor to Hartford-Empire Company. Original application filed 5/28/23. Divided and this application filed 2/8/27.

METHOD OF AND APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,812,534. June 30, 1931. Fred E. Jewett of Muncie, Indiana, assignor to Ball Brothers, Muncie, Ind.

MEANS FOR TREATING GLASS APPARATUS. U. S. 1,818,175. Aug. 11, 1931. Herbert Thomas, Charleston, W. Va., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 8/24/28.

Close to the Battle Lines in China

PROBABLY very few of our readers realize that not far, comparatively speaking, from the center of the prevailing disturbances in South Manchuria there is located a glass plant partly equipped with American automatic blowing and pressing machines, operating during normal conditions on a substantial scale, and at last accounts still going on.

This plant, the first to manufacture glass in South Manchuria, was established at Dairen in 1914 by the South Manchuria Railway Company which forms the backbone of the city of Dairen's industrial and commercial structure, which in turn depends directly on the railway's prosperity for its own, and to some extent by conditions in other parts of Manchuria.

Dairen is more or less self-contained. The city is located not a great distance from Port Arthur on the Yellow Sea. Mukden, a name which frequently appears in the "war" dispatches is within a few hours ride of Port Arthur on the South Manchurian Railway.

Dairen has its own factories for the production of a great many articles that are exported or consumed in the nearby territory. It has its own power supply, water supply and practically, under ordinary conditions, its own independent municipal administration.

The population according to a recent statement in *Commerce Reports* amounts to 390,640, composed of 101,963 Japanese, 286,736 Chinese, 1,231 Koreans and 710 other nationalities. The railway and its subsidiaries control the electric and gas works, shipping and dockyard companies,

FACTORY of the South Manchuria Glass Manufacturing Company
Dairen

CHINESE WORKMEN FORMING GLASS BY "LUNG-POWER," ALSO BY MECHANICAL METHODS

GENERAL VIEW OF THE PLANT
(Note the type of motive power employed on the railway)

CUT GLASS OF ARTISTIC QUALITY—ONE OF THE FACTORY'S NUMEROUS PRODUCTS

hotels, street railways and other industries. Approximately one-third of the entire population is dependent upon these enterprises. Much of the remaining population derives its sustenance indirectly from the expenditures of the railway company's employes. An estimate by the Dairen Chamber of Commerce gives the average income of citizens as 1,500 yen per year. The par value of the yen under normal conditions is around 50 cents United States currency.

The establishments handling foodstuffs and wearing apparel do approximately 75% of the total business of the city. In 1923 the Railway company's glass factory took in private capital, and in 1931 only 60% of the stock remained in possession of the Railway company. The glass factory is capitalized at 300,000 yen ($150,000). Its output in 1930 was valued at 700,000 yen but due to depressed business conditions and disturbances, production in 1931 was probably less than one-half that amount.

Foreign engineers were originally employed when the plant was first established but later these were all dispensed with and at the time this account was written the workmen consisted of about 25 Japanese and 270 Chinese. This establishment manufacturers all kinds of cut, blown and pressed glassware ranging from low priced goods to high grade cut glass products.

Previous to the commencement of fighting in South Manchuria it was estimated that 50% of the factory output was sold in China south of Shanghai, about 20% in Manchuria, and the remainder in North China.

Ceramists Lose Their Good Friend

The glass industry in common with the entire ceramic field owes an immense debt of gratitude to the late Edward Orton, whose death occurred at his home in Columbus, Ohio, on February 10. Recognized for many years past as the outstanding leader in ceramic education and honored in other ways as a scientist and technologist and also for his public spirited achievements, exemplified in the founding of the first school of ceramics in Ohio, his passing has caused universal regret throughout these industries.

General Orton's father, after whom he was named, was the first president of Ohio State University and he himself had been most active in his devotion to the interest not only of the University but of other educational institutions of various types. He specialized in ceramics and his work in the clay and other fields has undoubtedly been of benefit to the glass industry as well.

At a time when the American Ceramic Society needed a strong head, General Orton was drafted to serve as president. His retirement from that office was announced at the annual meeting of the Society in February, 1931. He held the rank of Brigadier General and the funeral was military in form with Company A, 1st Batallion 28th U. S. Infantry attending with colors. An address expressing the appreciation of his friends for General Orton's splendid qualities particularly appropriate and dignified in character was made by Dr. Lichliter of Columbus. It included Wordsworth's poem "The Character of the Happy Warrior"—

"Who, if he rise to station of command,
Rises by open means; and there will stand
On honorable terms, or else retire
And in himself possess his own desire;
Who comprehends his trust, and to the same
Keeps faithful with a singleness of aim,
And therefore does not stoop, nor lie in wait
For wealth, or honors, or for worldly state."

Henry Ford to Challenge Depression

Will "Risk His Last Dollar on Production"

Quotations from a report copyrighted by Nana, Inc., which appeared in the *New York Times* of Sunday, Feb. 28, appear below:

When Henry Ford gives the word for mass production on his new V-eight and improved model-A-four cars throughout the vast organization of the Ford Motor Company, as he will do probably next week, there will be revealed, well under way, one of the greatest epics of modern world industry. Mr. Ford plans to start an industrial revival which will be felt the world round. And to do that he is literally risking a great fortune.

"The American people have made the Ford Motor Company what it is," he holds. "We have nothing the public did not give us. No surplus exists for private benefit—every surplus is provided for future use.

"The future is here and we are going to do our utmost—risk everything, if necessary—to use this surplus which the public, through its dealings with us, has provided, to see if we cannot make what the country needs most—work, jobs!

"We are going to risk everything we've got to create useful work for just as many people as possible!"

Mr. Ford realizes that his own industries alone will not end the depression, but he believes that if he can operate to capacity, or nearly so, thousands of other industries will take heart and resume production and the depression will slowly disappear.

"You know, faith is catching!" he says.

Based on an anticipated production of 1,500,000 cars a year, gross purchases of raw materials and supplies will average more than $52,000,000 a month. During peak production in previous years purchases have exceeded $80,000,000 a month.

On this basis Mr. Ford will spend more than $300,000,000 in Detroit and Michigan for raw materials, manufactured supplies, freight and labor in the rest of 1932. In the Detroit district alone he will employ more than 100,000 men at the standard minimum wage of $6 a day and upward. The average monthly payroll in the Detroit district will run to more than $18,000,000 a month. Now it approximates $10,000,000.

For glass alone an expenditure of $10,100,000 is estimated much of which of course will be made in the Ford companies at Dearborn, Mich., Glassmere, Pa. and St. Paul, Minn.

The *Chicago Daily News*, published by Frank Knox, chairman of President Hoover's citizens' reconstruction organization to end hoarding, commenting today on Henry Ford's plan for a vast automobile building and marketing program, said:

"With Henry Ford sweeping into production at a rate he himself says 'will challenge depression if he risks his last dollar,' the attack on hard times, which began with the Reconstruction Finance Corporation and the anti-hoarding campaign is beginning to take hold of all industry. It will do more than merely take hold, for, after more than two years of delay and false principles, economic problems are now being fought on the common sense basis of reducing costs in line with the unavoidable reduction in popular income. * * *

"If every manufacturer will follow the example of the automobile industry, in making the best possible product at the lowest possible cost, there will be an end to unemployment, for even the smaller number of dollars will provide jobs for all. At the same time the powerful means taken to expand credit are building up an increase in buying power which the corrective steps will make doubly effective."

Ornburn Confirmed for Tariff Commission

On February 9, the Senate at Washington in secret session debated the appointment of Ira N. Ornburn of Connecticut as a Democratic member of the Tariff Commission. His appointment was then confirmed by a vote of 70 to 9. At the same time the Senate confirmed the appointment of Robert Lincoln O'Brien of Boston as chairman of the Tariff Commission, without debate or a record vote.

Last Year's Production of Polished Plate Glass

The total production of polished plate glass in the United States for the year 1931 was 86,913,988 sq. ft., as compared to 105,824,074 sq. ft. produced in the preceding year, 1930. These are the figures compiled by P. A. Hughes, secretary of the Plate Glass Manufacturers of America.

Society of Glass Technology

Through the courtesy of Mr. C. C. Paterson, O. B. E., M. I. E. E., the Director of the G. E. C. Research Laboratories at Wembley, the London Section of the Society of Glass Technology was able to visit the Laboratories on Wednesday evening, January 13th, and the appreciation of the members was demonstrated by a record attendance. Nearly one hundred visitors were present.

Demonstrations of typical examples of research were given by members of the G. E. C. staff and these included such things as large glass-to-glass and glass-to-metal joints, special effects in high tension discharge tubes, gas discharge tubes which will strike on normal circuit voltages, the scattering of light by particles in a transparent medium, the directional effect of loud-speakers and the application of statistics to the study of data derived from tests to destruction of samples selected from mass-produced articles.

After an interval for refreshments the members were then shown some of the experimental work which is in progress in connection with glass and refractories.

In reply to a vote of thanks proposed by Mr. F. G. Orme, O. B. E., F. C. I. S., Chairman of the London Section, Mr. Paterson expressed his satisfaction at the large attendance of members and drew attention to the flourishing state of the London Section which was so spontaneously supported by its members.

Society of Glass Technology, London Section

The London Section of the Society of Glass Technology met at Messrs. Holophane, Ltd., Elverton Street, Westminster, February 10th. Mr. H. Hepworth Thompson, managing director of Messrs. Holophane, Ltd., was in the chair.

A paper on "The History of the London Glass Bottle Trade," by Mr. R. Sharp, outlined the development of the hand-made glass bottle trade, with particular reference to the London bottle works, from its earliest beginnings to the present day as a distinct branch of the glass industry. His remarks on the earlier types of bottles were illustrated by lantern slides, and the paper aroused considerable interest and discussion.

Another paper on "The Development of the Glass Instrument Trade," by Mr. H. J. Elliott and Mr. V. Stott, B. A., was postponed until a subsequent meeting owing to the great interest taken in the first paper and to the amount of discussion which followed.

Window Glass Prices Increased

The American Window Glass Company has announced that in an effort to stabilize prices it has decided to increase window glass prices an average of 10 per cent, based on the price list of April 23, 1928. The sale of Fourth Quality and C Quality and "grinders" has been discontinued.

Building a New Ford Motor Glass Furnace

Toledo Engineering Company, Toledo, O., recently announced the placing with their organization by the Ford Motor Company of a contract for a glass tank of "luminous flame" type. Some construction work has also been arranged for at the Company's St. Paul glass plant.

The continuous furnaces which were operated at the Rouge plant over a considerable period have been demolished.

New Consulting Service

Theodore Lenchner formerly connected with Roessler & Hasslacher Chemical Company advises that his services are now available for consultation on glass making problems, including color work in which he has had extended experience. He may be reached at 218 First Street, Pittsburgh, Pa.

Information Wanted

A reader desires to learn the best method of cutting off the tops of one gallon glass demijohns in order to use the lower parts as water tanks. Soaking a cotton cord in kerosene oil, fastening it around the demijohn and setting fire to the oil does the trick but leaves the edge of the tank very uneven and rough. Would it be better to fill the demijohn with water and tie the cord around it at the water level. Please address replies to the Editor.

PERFORMANCE talks

532.38 Tons of Opal Glass
melted in this tank
in 263 working days

This remarkable record was made by the Inland Glass Co., Chicago, using Lacledе-Christy SUPERFLUX Blocks.

Here are the facts, supplied by Mr. Karl Uhrman, Supt.:

Tank originally started up on . . 4/25
Tank shut down 10/14
Tank again started up 12/1
Tank finally closed down 4/23

263 working days — 532.38 tons of opal glass melted.

Your own plant conditions and practices may be different from those at Inland, but at any rate, here is a record to shoot at. If you are ready now to close down a tank for repairs, write, wire or phone us regarding a quotation or shipment on either of our two famous brands — Superflux or Buckeye.

LACLEDE-CHRISTY, ST. LOUIS, U.S.A.

SUPERFLUX BLOCKS
A LACLEDE-CHRISTY PRODUCT

Readers' Wants and Offers, Inquiries Received, What the World Wants—Page 11

Current Prices of Glass-Making Materials

February 23, 1932

Quotations furnished by various producers, manufacturers and dealers.

Acid		Carlots	Less Carlots
Citric (dom.)	lb.	..	.33½
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.24½
Alcohol, denatured	gal.	..	..
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb.	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.15½
Ammonia water (NH_4OH) 26° drums	lb.		..
Antimony, metallic (Sb)	lb.	.02½	.02¾
Antimony oxide (Sb_2O_3)	lb.	..	.09½
Antimony sulphide (Sb_2S_3)	lb.	..	.08½
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.14 .04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05¼
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	..	.07¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.0625-.08125
Refined	lb.	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.65-.90
Orange	lb.	..	.60-1.10
Yellow	lb.	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb.	..	.20
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	1.35
In 10 lb. tins	lb.	..	1.45
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.17-.19
Black prepared	lb.	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland			
Kryolith)	lb.	.09	.09¼
Synthetic (Artificial)	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb		..	1.15-1.20
*Feldspar—			
100 mesh	ton	11.50-17.50	12.00-18.00
80 mesh	ton	11.00-11.50	13.00
40 mesh	ton	10.75-11.00	12.00
20 mesh	ton	9.50- 9.75	10.00
Fluorspar (CaF₂) domestic, ground, 96-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	30.00	..
In bags or barrels	ton	34.00	39.00
Imported	ton	30.00-31.00	33.00-37.00
Formaldehyde	lb.	..	.07
Graphite (C)	lb.	..	04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.0425
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00

*Spot Shipments.

Kryolith (see Cryolite)		Carlots	Less Carlots
Lead chromate ($PbCrO_4$)	lb.	..	30
Lead oxide (Pb_3O_4) (red lead)	lb.	.0625	.0675
Litharge (PbO)	lb.	.0525	.0575
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	5.50	..
Burnt (CaO) ground, in bulk	ton	5.00	..
Burnt, ground, in paper sacks	ton	7.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15	..
Limestone ($CaCO_3$)		1.50-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	07
light (in bbls.)	lb.	..	23
extra light (in bbls.)	lb.	..	.3
Magnesium carbonate ($MgCO_3$)	lb.	.06	.10
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb	.09	.09¼
Ground	lb	.11	12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06¼	.07
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.25
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.17½-.18
Rochelle salts, bbls.	lb.	..	.16
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	
Selenium (Se)	lb.	..	1.70
Silver nitrate ($AgNO_3$) (100 oz.) per oz.		..	.23¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb	1.05	..
In barrels	Per 100 lb.	1.38	1.90-2.13
In bags	Per 100 lb.	1.17½	1.72½-1.92½
Spot orders.. .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb	2.50	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.		..	..
95 per cent.	Per 100 lb	1.67-177	1.72-1.82
Sodium selenite (Na_2SeO_3)	lb	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05½	.06
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb	3.45	1.80-4.00
Flowers, in bags	Per 100 lb	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb	.37½	.39
Tin oxide (SnO_2) in bbls.	lb.	.28	.29½
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb	..	2.75
Yellow	lb	..	1.50
Zinc oxide (ZnO)	lb.	.08½	.12
American process. Bags	lb	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		07	07½-.08
Crude. Gran. (Milled .005-.02c higher)		03¼	04- 05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to January 23, 1932.

	December 1930 Quantity	December 1930 Value	December 1931 Quantity	December 1931 Value	Twelve Months Ending December 1930 Quantity	Twelve Months Ending December 1930 Value	Twelve Months Ending December 1931 Quantity	Twelve Months Ending December 1931 Value
Glass and glass products (Total)	.....	$596,677	.....	$427,634	.....	$9,120,046	.....	$6,897,495
Plate and window glass—								
Window glass, common, box 50 sq. ft.	762	3,754	942	4,353	15,544	84,014	8,486	40,909
Plate glass, unsilvered, sq. ft.	192,459	51,726	282,868	70,132	3,361,408	1,035,759	3,708,493	1,114,958
Other window and plate glass lbs.	332,987	25,537	243,772	25,784	5,188,662	443,446	2,859,494	294,379
Glass containers (bottles, vials and jars)	.. ....	208,354	.....	110,238	.....	2,992,326	.....	2,087,150
Table glassware, plain	.. ....	75,305	.....	41,316	.....	1,201,188	.....	877,013
Table and other glassware, cut or engraved	.....	7,486	.....	3,287	.....	96,709	.....	80,365
Lamp chimneys and lantern globes lbs.	.....	9,921	.....	5,398	.....	217,530	.....	82,802
Globes and shades for lighting fixtures lbs.	.....	40,671	.....	26,731	.....	582,020	.....	409,522
Chemical glassware lbs.	20,755	16,425	13,549	13,429	269,244	230,760	159,537	151,908
Electrical glassware, except for lighting lbs.	81,317	6,222	99,882	5,908	3,462,055	239,654	1,329,952	86,013
Other glassware	.....	151,276	.....	121,058	.....	1,997,240	.....	1,672,476

IMPORTS

Corrected to January 23, 1932.

Glass and glass products	.. ....	$605,676	.....	$422,721	.....	$8,874,962	.....	$6,396,372
Cylinder, crown, and sheet—								
Plain dut. lb.	667,007	25,455	337,719	11,477	14,670,243	572,929	7,720,973	292,152
Bent, beveled, colored, etc. dut. lb.	111,787	20,562	106,398	17,741	.. ..	345,737	1,766,984	253,504
Plate glass dut. sq. ft.	651,993	159,620	416,185	78,159	5,874,931	1,270,844	4,886,671	1,125,645
Glass mirrors	18	148	63	410	[2]427	[2]1,048	1,926	5,104
Rolled, cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	.....	6,947	.....	21,419	.....	[2]29,036	.....	114,781
Laminated glass and manufactures, and plated glass	.....	1,315	.....	1,739	.....	[2]13,868	.....	19,063
Bottles, vials, jars, and other containers	.....	68,939	.....	29,744	.....	1,138,381	.....	534,242
Scientific articles and utensils dut.	.....	24,921	.....	22,567	.....	502,486	.....	388,568
Tubes and rods dut.	.....	8,045	.....	9,960	.....	[2]52,385	.....	127,139
Illuminating articles dut.	.....	44,379	.....	30,312	.....	601,895	.. ....	369,233
Blown glass articles—		151,121	.. ....	.....	.....	3,038,095	.. ....	.....
Bulbs for electric lamps, without filament dut.	.....	.....	1,403,300	11,291	.....	.....	13,221,473	118,695
Other blown glass articles dut.	.....	12,444	.....	20,804	.....	205,650	.. ....	139,004
Pressed glass articles	.. ....	81,780	.....	68,326	.....	1,102,608	.....	922,372
Other glassware	.. ..							

[2]Beginning June 18, 1930.